Check List the journal of biodiversity data
ANNOTATED LIST OF SPECIES

An updated checklist of the marine birds (Aves) of Golfo Dulce, southern Costa Rica

Alejandra Rojas-Barrantes[1], Luis Sandoval[2, 3]

1 *Independent researcher, Golfito, Puntarenas, Costa Rica*
2 *Laboratorio de Ecología Urbana y Comunicación Animal, Escuela de Biología, Universidad de Costa Rica*
3 *Colección de Ornitología, Museo de Zoología, Centro de Investigación en Biodiversidad y Ecología Tropical, Universidad de Costa Rica*

Corresponding author: *Alejandra Rojas-Barrantes (pajareando@avesdegolfito.org)*

Abstract. Golfo Dulce is a fjord-like embayment on the southern Pacific coast of Costa Rica, which encompasses the marine protected area of Piedras Blancas National Park. The gulf is surrounded by mangroves, rocky shores, and sandy beaches that are home to migratory and resident bird species. Here, we provide a checklist of 73 marine birds, including records of six years of annual counts and incidental observations in Golfo Dulce. This paper represents an updated bird list, based on the 1998 Basic Information Units from Instituto Nacional de Biodiversidad. We added 16 species to the list, showing the importance of maintaining a monitoring program of marine birds in the Golfo Dulce area. We have also demonstrated the valuable contributions of citizen science for obtaining scientific information.

Key words. Bird migration, coastal wetland, marine biodiversity, Piedras Blancas National Park, seabirds, shorebirds, waterbirds

Rojas-Barrantes A, Sandoval L (2024) An updated checklist of the marine birds (Aves) of Golfo Dulce, southern Costa Rica. Check List 20 (1): 184–198. https://doi.org/10.15560/20.1.184

INTRODUCTION

Given its unique oceanographic and geomorphological conditions, Golfo Dulce in the southern Pacific coast of Costa Rica is considered one of four biological systems with a fjord-like structure in the tropics (Knauss 1978; Cortés 1992; Hebbeln et al. 1996). Along this tropical fjord, there are four coastal wetland habitats: mangroves, sandy beaches, sea grasses, and coral reefs (Cortés 1992; Weissenhofer et al. 2008; Samper-Villarreal and Silva-Benavides 2015; Samper-Villarreal et al. 2018). Aditionally, the gulf comprises rocky shores and small islets (Los Mogos and Isla Pelícano).

As explained by Barrantes and Chaves-Campos (2009), the complex topography and high tidal fluctuations of the Costa Rican Pacific coast have resulted in numerous habitats appropriate for marine birds. Despite the biological importance of Golfo Dulce for avian diversity, marine-bird studies or long-term monitoring in this environment are marginal, in comparison to studies regarding terrestrial birds in adjacent areas.

The first recorded list of marine birds in Golfo Dulce was built upon previous observations and was subsequently deposited on the former Basic Information Units (Unidades Básicas de Información; **UBI**) from Instituto Nacional de Biodiversidad in 1998. Although the UBI platform is no longer working, the marine birds list is available in Quesada-Alpízar et al. (2006). Origin of the data (dates and references) were not mentioned. Since then, no major updates have been made to the marine bird diversity status of Golfo Dulce.

Global changes, encompassing extreme climatic events, which are expected to impact marine and coastal zones (BIOMARCC-SINAC-GIZ 2013), make it essential to understand the distribution of birds in marine environments and coastal wetlands in a time frame. In addition to global changes, local anthropogenic threats to bird habitats in the Golfo Dulce region are ongoing. In the surrounding areas of Golfo Dulce (Osa and Golfito political divisions), tourism and real estate development have significantly expanded since the 2000s, especially in 2007–2009. Environmental impacts resulting from these activities have included damage to mangroves (Román and Angulo 2013).

Due to cause–effect association of microclimates and habitats, marine birds are indicators of a marine ecosystem's integrity (Rajpar et al. 2018). Therefore, fields like ecology and conservation biology that depend on taxonomic data require baseline information and continuous updating of species lists. Checklists can provide reliable information on changes in bird populations, phenology, and geographic and climate patterns at a regional scale (Droege et al. 1998), information that is required to inform future conservation

OPEN ACCESS

Academic editor: Alexandre Pedro Selvatti
Received: 22 December 2022
Accepted: 15 January 2024
Published: 1 February 2024

Copyright © The authors. This is an open-access article distributed under terms of the Creative Commons Attribution License (Attribution 4.0 International – CC BY 4.0)

and management practices. Hence, we provide here updated information on marine birds of the Golfo Dulce, which will be especially important at the current juncture of climate change.

STUDY AREA

Golfo Dulce (between 08°27′N–08°45′N and 083°07′W–083°30′W) is a 14 km wide and 50 km long gulf located on the southeast of Costa Rica's Pacific coast; the gulf has an area of 750 km^2 (Wolff et al. 1996) (Figure 1). This environment is part of the Tropical Eastern Pacific and comprises 21.5% of the marine biodiversity of the Pacific coast of Costa Rica (Morales-Ramírez 2011). Since the creation of Piedras Blancas National Park (**PBNP**) in 1991, 1200 ha are inside the marine protected area (SINAC 2015).

The inner basin of the Golfo Dulce (Figure 1) is 215 m deep and a shallow mouth 70 m deep; there is flux stratification within the water column of the gulf, in a pattern typical of fjord-like estuaries (Richards et al. 1971). The coral reefs in the gulf have a high topographic relief, low coral diversity, and live coral coverage, but a high dead coral coverage (Cortés 1992). The high diversity of fishes in Golfo Dulce (Cortés 1992; Bussing and López 1996; Guzmán-Mora and Molina-Ureña 2008; Palacios-Martínez 2015) may influence the occurrence of sea birds, herons, and gulls.

The gulf is surrounded by four main estuaries forming expansive mangroves: those of the Esquinas and Coto Colorado rivers in the northern mainland and the Rincón and Tigre rivers draining from the Osa Peninsula. Six species of mangrove occur in Golfo Dulce: *Rhizophora mangle* L., *Rhizophora racemosa* G.Mey, *Pelliciera rhizophorae* Planch. & Triana, *Avicennia germinans* (L.) L., *Laguncularia racemosa* (L.) C.F.Gaertn., and *Conocarpus erectus* L. (SINAC 2015). Small patches of swamp forest dominated by the tree *Pterocarpus officinalis* Jacq. are also part of the coastal region. The Esquinas and Coto Colorado mangroves are bordered by these swamp forests, where *P. officinalis* is associated with *Mora oleifera* (Triana ex Hemsl.) Ducke, as described by Allen (1956). Steep rocky shores, rocky islets, and sandy beaches with gravel alternate along the coast, and this is especially evident in PBNP. These beaches transition into coastal forests where the spindrift, saltwater, and dry soil conditions influence the vegetation (Weissenhofer et al. 2008).

METHODS

We define marine birds as birds that spend at least a part of their life in a marine habitat, as defined by Schreiber and Burger (2001). Marine habitats include coastal areas, islands, estuaries, wetlands, and oceanic islands. Accordingly, we classify marine birds into three groups for:

- **Seabirds** are colonial species that feed in salt waters and often migrate long distances from breeding grounds to wintering areas. In some cases, these birds may connect geographically different marine

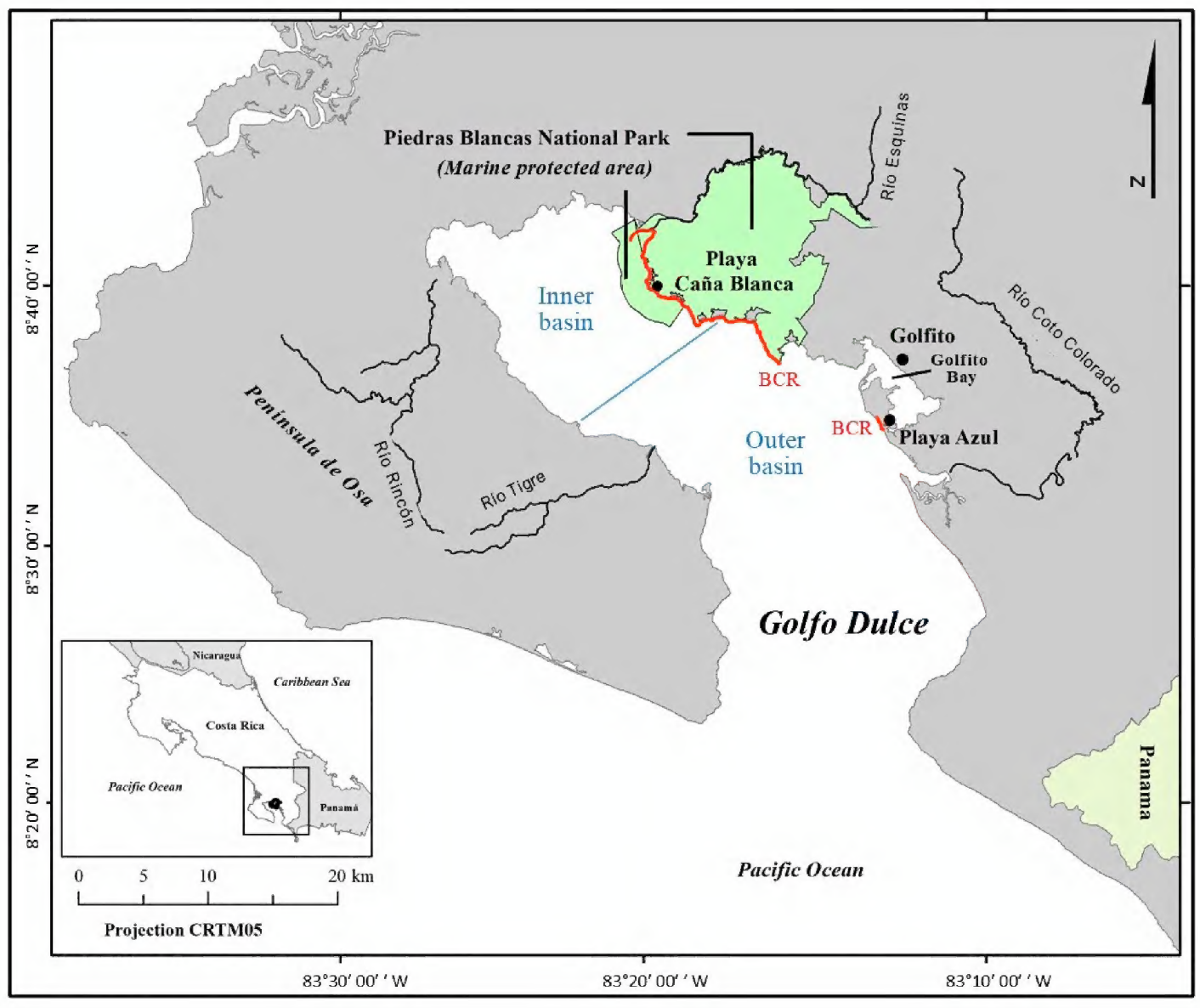

Figure 1. Golfo Dulce, on the southern Pacific coast of Costa Rica. Bird counts routes (BCR) are shown in red. The division of the gulf into inner and outer basin is shown as a blue line.

environments. This group includes Phaetontidae Brandt, 1840, Procellariidae Leach, 1820, Fregatidae Degland & Gerbe, 1867, Sulidae Reichenbach, 1849, Phalacrocoracidae Reichenbach, 1850, Pelecanidae Rafinesque, 1815, Haematopodidae Bonaparte, 1838, Stercorariidae J.E. Gray, 1871, and Laridae Rafinesque, 1815.

- **Shorebirds** spend their lives on sandy beaches, mudflats, and shores of rivers and lakes, and they generally only interact with the edge of the marine environment. This group includes Recurvirostridae Bonaparte, 1854, Charadriidae Leach, 1820, and Scolopacidae Rafinesque, 1815.
- **Waterbirds** inhabit and feed mostly in freshwater and generally interact with the marine environment only in the coastal zone. This group includes Ciconiidae J.E. Gray, 1840, Anhingidae Reichenbach, 1849, Ardeidae Leach, 1820, and Threskiornitidae Richmond, 1917.

Because no species were collected and non-invasive methods were used to obtain data, scientific permits for collection were not required. Among the data reported here, some observations are incidental (observations in 2007 and 2014–2023), while all other observations derive from bird counts (in 2015–2017 and 2021–2023), following the area-search method. The selected area was a 24 km diameter circle, following the National Audubon Society's Bird Count guidelines (2022). The two methods used in this study are:

(1) Area search (or route count). This method, usually repeated, attempts to identify, and count all the birds in a specified area within a specific time. It is most effective if repeated at the same time of day. It may involve an area search of the entire study site or of selected plots within the area (Ralph 1981; Ralph et al. 1993). The annual bird counts we undertook (Golfito Bird Counts, a citizen-science approach) were made in December, on the same day and at the same time (5:00–13:00 h) in each year. Teams of birders included a leader (a biologist or expert naturalist with a proven knowledge of bird diversity and tasked with maintaining data quality) and amateur bird observers. Specialists were chosen on the basis of their previous experience working with birds and their formal certifications as professionals in the field of biology or in nature guiding. One team of observers, including at least one specialist and four amateurs, surveyed each of these areas:

34 km (12.73 km^2) by boat (outboard motor) in the northern Golfo Dulce from Punta Gallardo to the Esquinas river estuary (Figure 1 shown as red lines).

9 km (3 km^2) in the southern Golfo Dulce from the Coto Colorado river estuary to Playa Azul and Punta Piedra; one sector by boat (outboard motor) and one sector walking (Figure 1, shown as red lines)

The search area included mangroves, river estuaries, sandy beaches, rocky shores, and an extension of 1 km from the land into the ocean. Birds were identified using field guides (Garrigues and Dean 2014) and from photographs. In the list, 44 records originate from the Golfito Bird Count census.

(2) Incidental observations. This method is particularly important in determining the presence of rare and unusual species not normally observed, not captured by nets or traps, or missed during regular censuses or counts (Ralph et al. 1993). This is an unstandardized method. The incidental observations included in our list are data obtained by us while conducting birdwatching tours or fieldwork on other taxa in the study area from 2007 to 2017 for LS and from 2014 to 2023 for ARB. All these records are based on observations of birds seen and identified on-site. We categorized our incidental observations as either from the inner or outer basins of the Golfo Dulce using an imaginary line (Figure. 1, shown in blue) based on Cortés (1990). The incidental observations covered the whole of the study area (750 km^2). Twenty-five records in the list originate from our incidental observations.

Data obtained from bird counts were deposited in the Costa Rican Ornithologist's Union (Unión de Ornitólogos de Costa Rica) database, and the Golfito Bird Count results have been documented in the eBird platform since 2021. We also reviewed the literature to find and verify historical records and compare our results to those obtained from UBI records. We used Google Scholar and accessed repositories in the Universidad Nacional, Universidad de Costa Rica, and Universidad Estatal a Distancia to find research articles, field-course reports, theses, and dissertations using five keywords (both in English and Spanish): "Golfo Dulce", "Golfo Dulce birds", "Golfo Dulce marine birds", "Costa Rica marine birds", and "Golfito birds". The literature found the following references: Araya Ajoy (2005), Young and Zook (2006), Barrantes and Chaves-Campos (2009), Morales-Ramírez (2011), Bessesen (2015). A field guide (Garrigues and Dean 2014) was also reviewed to verify records of rare species, but only data specifying the Golfo Dulce were included in our list. The UBI bird list (Quesada-Alpízar et al. 2006) was cited only by Morales-Ramírez (2011).

In the present list, three records originate from this literature review (Garrigues and Dean 2014, Young and Zook 2016) and confirm the mentioned species in the UBI that were not observed in this study. We used eBird, a citizen science platform, which has become integrated with existing regional platforms, to increasing the data available (Sullivan et al. 2014). All records in eBird (2002–2023) filtered by Osa Peninsula and Golfito were included in our data. Single , photographic, and audio records were considered, since rare or unusual observations on this platform are reviewed by experts. One record originates from our review of eBird.

The checklist is arranged following Sandoval and Sánchez (2020), and the taxonomy is according to the American Ornithological Society (Chesser et al. 2023). Species status resident, migratory, or breeding migrant in Costa Rica follows the information by Stiles and Skutch (1989) and Garrigues and Dean (2014). Abundance codes follow the guidelines developed by the American Birding Association (2023). For this

purpose, we estimated abundance averaging the number of individuals observed on the area search or route count methods, and these values were used to classify species as rare, uncommon, and common. Incidental observations were used to classify species as accidental or rare.

- **Common.** Found in moderate to large numbers (>10 individuals on average) and easily found in appropriate habitat at the right time of year.
- **Uncommon.** Found in small numbers (2–10 individuals on average), and usually, but not always, found with some effort in appropriate habitat at the right time of year.
- **Rare.** Occurs annually in very small numbers (<2 individuals on average). Not to be expected on any given day but may be found with extended effort over the course of the appropriate season.
- **Accidental.** Highly unpredictable (<3 reports under incidental observations). Not typically found most years, with fewer than 10–15 historical records. Also included are vagrants out of their usual range.

RESULTS

Our results indicate that the marine avifauna of Golfo Dulce is composed of 73 species in 16 families. Twenty species are resident and 50 are Nearctic migrants. Two species have resident and migratory populations, and one is a breeding migrant (Table 1). In this list four species are classified as globally Near Threatened by the International Union for Conservation of Nature (IUCN 2023).

We document 32 species from the Golfo Dulce, of which we classify 28 as rare. Sixteen species are newly recorded from the area, in relation to the UBI list; these are marked as "newly recorded from the area".

Table 1. List of the marine birds found in Golfo Dulce, southern Costa Rica region between 2007 and 2023, their status, classification, abundance, habitat (main habitat used by the species), and source of record. Status: R = Resident, M = Migratory, BM = Breeding migrant.

Taxon	Common name	Status	Classification	Abundance	Habitat	Source of record
Recurvirostridae (2)						
Himantopus mexicanus Linnaeus, 1758	Black-necked Stilt	M	Shorebird	Rare	Shore	Incidental obs,
Recurvirostra americana Gmelin, 1789	American Avocet	R	Shorebird	Accidental	Shore	Incidental obs.
Haematopodidae (1)						
Haematopus palliatus Temminck, 1820	American Oystercatcher	R	Seabird	Rare	Rocky shore	Census
Charadriidae (7)						
Pluvialis squatarola Linnaeus, 1758	Black-bellied Plover	M	Shorebird	Uncommon	Shore	Census
Pluvialis dominica Müller, 1766	American Golden-Plover	M	Shorebird	Rare	Shore	Incidental obs.
Charadrius vociferus Linnaeus, 1758	Killdeer	M	Shorebird	Rare	Shore	Incidental obs.
Charadrius semipalmatus Bonaparte, 1825	Semipalmated Plover	M	Shorebird	Common	Shore	Census
Charadrius wilsonia Ord, 1814	Wilson's Plover	R	Shorebird	Common	Shore	Census
Charadrius collaris Vieillot,1818	Collared Plover	M	Shorebird	Uncommon	Shore	Census
Charadrius nivosus Cassin, 1858†	Snowy Plover	M	Shorebird	Uncommon	Shore	Incidental obs.
Scolopacidae (20)						
Numenius phaeopus Linnaeus, 1758	Whimbrel	M	Shorebird	Common	Shore	Census
Limosa fedoa Linnaeus, 1758	Marbled Godwit	M	Shorebird	Uncommon	Shore	Census
Arenaria interpres Linnaeus, 1758	Ruddy Turnstone	M	Shorebird	Common	Rocky shore	Census
Calidris virgata Gmelin, 1789	Surfbird	M	Shorebird	Rare	Rocky shore	Incidental obs.
Calidris himantopus Bonaparte, 1826	Stilt Sandpiper	M	Shorebird	Rare	Shore	Incidental obs.
Calidris alba Pallas, 1764	Sanderling	M	Shorebird	Uncommon	Shore	Census
Calidris bairdii Coues, 1861	Baird's Sandpiper	M	Shorebird	Common	Shore	Census
Calidris minutilla Vieillot, 1819	Least Sandpiper	M	Shorebird	Common	Shore	Census
Calidris pusilla Linnaeus, 1766†	Semipalmated Sandpiper	M	Shorebird	Common	Shore	Census
Calidris mauri Cabanis, 1857	Western Sandpiper	M	Shorebird	Common	Shore	Census
Limnodromus griseus Gmelin, 1789	Short-billed Dowitcher	M	Shorebird	Uncommon	Shore	Census
Limnodromus scolopaceus Say, 1823	Long-billed Dowitcher	M	Shorebird	Rare	Shore	Census
Actitis macularius Linnaeus, 1766	Spotted Sandpiper	M	Shorebird	Common	Shore	Census
Tringa solitaria Wilson, 1813	Solitary Sandpiper	M	Shorebird	Uncommon	Shore	Census
Tringa incana Gmelin, 1789	Wandering Tattler	M	Shorebird	Rare	Rocky shore	Incidental obs.
Tringa flavipes Gmelin, 1789	Lesser Yellowlegs	M	Shorebird	Uncommon	Shore	Census
Tringa semipalmata Gmelin, 1789	Willet	M	Shorebird	Common	Shore	Census
Tringa melanoleuca Gmelin, 1789	Greater Yellowlegs	M	Shorebird	Common	Shore	Census
Phalaropus fulicarius Linnaeus, 1758	Red Phalarope	M	Shorebird	Rare	Pelagic	Incidental obs.
Phalaropus lobatus Linnaeus, 1758	Red-necked Phalarope	M	Shorebird	Rare	Pelagic	Incidental obs.

Taxon	Common name	Status	Classification	Abundance	Habitat	Source of record
Stercorariidae (2)						
Stercorarius pomarinus Temminck, 1815	Pomarine Jaeger	M	Seabird	Rare	Pelagic	Incidental obs.
Stercorarius parasiticus Linnaeus, 1758	Parasitic Jaeger	M	Seabird	Rare	Pelagic	Incidental obs.
Laridae (13)						
Leucophaeus atricilla Linnaeus, 1758	Laughing Gull	M	Seabird	Common	Shore	Census
Leucophaeus pipixcan Wagler, 1831	Franklin's Gull	M	Seabird	Rare	Shore	Incidental obs., census
Chroicocephalus philadelphia Ord, 1815†	Bonaparte's Gull	M	Seabird	Rare	Shore	Literature
Anous stolidus Linnaeus, 1758 *	Brown Noddy	M	Seabird	Rare	Pelagic	Literature
Onychoprion anaethetus Scopoli, 1786	Bridled Tern	BM	Seabird	Rare	Pelagic	Incidental obs.
Sternula antillarum Lesson, 1847	Least Tern	M	Seabird	Rare	Shore	Incidental obs.
Gelochelidon nilotica Gmelin, 1789	Gull-billed Tern	M	Seabird	Rare	Shore	Incidental obs.
Chlidonias niger Linnaeus, 1758	Black Tern	M	Seabird	Common	Pelagic	Census
Sterna hirundo Linnaeus, 1758	Common Tern	M	Seabird	Uncommon	Shore	Incidental obs.
Thalasseus maximus Boddaert, 1783	Royal Tern	M	Seabird	Common	Shore	Census
Thalasseus sandvicensis Latham, 1787	Sandwich Tern	M	Seabird	Common	Shore	Census
Thalasseus elegans Gambel, 1849	Elegant Tern	M	Seabird	Common	Shore	Census
Rynchops niger Linnaeus, 1758	Black Skimmer	M	Seabird	Rare	Shore	Incidental obs.
Phaethontidae (1)						
Phaethon aethereus Linnaeus, 1758	Red-billed Tropicbird	M	Seabird	Accidental	Pelagic	Incidental obs.
Procellariidae (3)						
Ardenna pacifica Gmelin, 1789	Wedge-tailed Shearwater	M	Seabird	Rare	Pelagic	Incidental obs.
Puffinus subalaris Ridgway, 1897	Galapagos Shearwater	M	Seabird	Rare	Pelagic	Incidental obs.
Puffinus lherminieri Lesson, 1839	Audubon's Shearwater	M	Seabird	Rare	Pelagic	Incidental obs.
Ciconiidae (1)						
Mycteria americana Linnaeus, 1758	Wood Stork	R	Waterbird	Rare	Shore	Census
Fregatidae (1)						
Fregata magnificens Mathews, 1914	Magnificent Frigatebird	R	Seabird	Common	Shore	Census
Sulidae (5)						
Sula dactylatra Lesson, 1831	Masked Booby	R	Seabird	Rare	Pelagic	Incidental obs.
Sula nebouxii Milne-Edwards, 1882	Blue-footed Booby	R	Seabird	Rare	Pelagic	Incidental obs.
Sula leucogaster Boddaert, 1783	Brown Booby	R	Seabird	Common	Pelagic	Census
Sula sula Linnaeus, 1766	Red-footed Booby	M	Seabird	Rare	Pelagic	Incidental obs.
Sula variegata Tschudi, 1843	Peruvian Booby	M	Seabird	Rare	Pelagic	Ebird platform
Anhingidae (1)						
Anhinga anhinga Linnaeus, 1766	Anhinga	R	Waterbird	Common	Shore	Census
Phalacrocoracidae (1)						
Nannopterum brasilianum Gmelin, 1789	Neotropic Cormorant	R	Seabird	Common	Shore	Census
Pelecanidae (1)						
Pelecanus occidentalis Linnaeus, 1766	Brown Pelican	R	Seabird	Common	Shore	Census
Ardeidae (12)						
Tigrisoma mexicanum Swainson, 1834	Bare-throated Tiger-Heron	R	Waterbird	Common	Shore	Census
Ardea herodias Linnaeus, 1758	Great Blue Heron	M	Waterbird	Common	Shore	Census
Ardea alba Linnaeus, 1758	Great Egret	R,M	Waterbird	Common	Shore	Census
Egretta thula Molina, 1782	Snowy Egret	R,M	Waterbird	Common	Shore	Census
Egretta caerulea Linnaeus, 1758	Little Blue Heron	M	Waterbird	Common	Shore	Census
Egretta tricolor Müller, 1776	Tricolored Heron	M	Waterbird	Common	Shore	Census
Egretta rufescens Gmelin, 1789†	Reddish Egret	M	Waterbird	Uncommon	Shore	Census
Agamia agami Reichenbarch, 1853†	Agami heron	R	Waterbird	Rare	Shore	Literature
Bubulcus ibis Linnaeus, 1758	Cattle Egret	R	Waterbird	Common	Shore	Census
Butorides virescens Linnaeus, 1758	Green Heron	R	Waterbird	Common	Shore	Census
Nyctanassa violacea Linnaeus, 1758	Yellow-crowned Night-Heron	R	Waterbird	Common	Shore	Census
Cochlearius cochlearius Linnaeus, 1766	Boat-billed Heron	R	Waterbird	Common	Shore	Census
Threskiornithidae (2)						
Eudocimus albus Linnaeus, 1758	White Ibis	R	Waterbird	Common	Shore	Census
Platalea ajaja Linnaeus, 1758	Roseate Spoonbill	R	Waterbird	Uncommon	Shore	Census

†Near Threatened. All other species are classified as Least Concern (IUCN 2023).
*Reported by Young and Zook (2016).
†Reported by Garrigues and Dean (2014)

Recurvirostridae

***Himantopus mexicanus* Linnaeus, 1758**
Black-necked Stilt
Figure 2A

Observations. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°43′11″N, 083°20′18″W; 14.V.2018; A. Rojas-Barrantes obs.; first observed in the estuary of Esquinas river, solitary. The species was also observed solitary or in small groups in sandy beaches of the northern region of Golfo Dulce and Tigre river.

Identification. Large shorebird with black-and-white pattern. Very long orange legs and pointy bill are distinctive.

***Recurvirostra americana* Gmelin, 1789**
American Avocet
Newly recorded from the area
Figure 2B

Observations. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°40′43″N, 083°19′32″W; 18.IX.2018; A. Rojas-Barrantes obs; this provides the first record for the southern Pacific coast of Costa Rica. This species is a casual migrant in the country and has been reported in Palo Verde (northern Pacific coast), Tortuguero (Caribbean slope), Lake Arenal, and Chomes (central Pacific coast) (Garrigues and Dean 2014). *R. americana* forages in saltmarshes and ponds, but we observed a single individual foraging at low tide at Playa Caña Blanca (Figure 1), a sandy beach in northern Golfo Dulce. Later, in December 2022, *R. americana* was observed again foraging along with waterfowl in rice fields near the mouth of the Coto Colorado river, reported on eBird database https://ebird.org/checklist/S123757261 with photographic record.

Identification. Large shorebird with black-and-white pattern in wings and back. Long upturned bill. Long, gray-blue legs. No other shorebird has these characteristics.

Haematopodidae

***Haematopus palliatus* Temminck, 1820**
American Oystercatcher
Newly recorded from the area
Figure 2C

Observations. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°34′19″N, 083°09′43″W; 15.XII.2015; A. Rojas-Barrantes obs.; first observed in Playa Azul, a sandy beach by the estuary of Coto Colorado river. Also seen foraging in sandy beaches and rocky shores, solitary or in small groups.

Identification. Large and straight red to orange bill, and black head are distinctive.

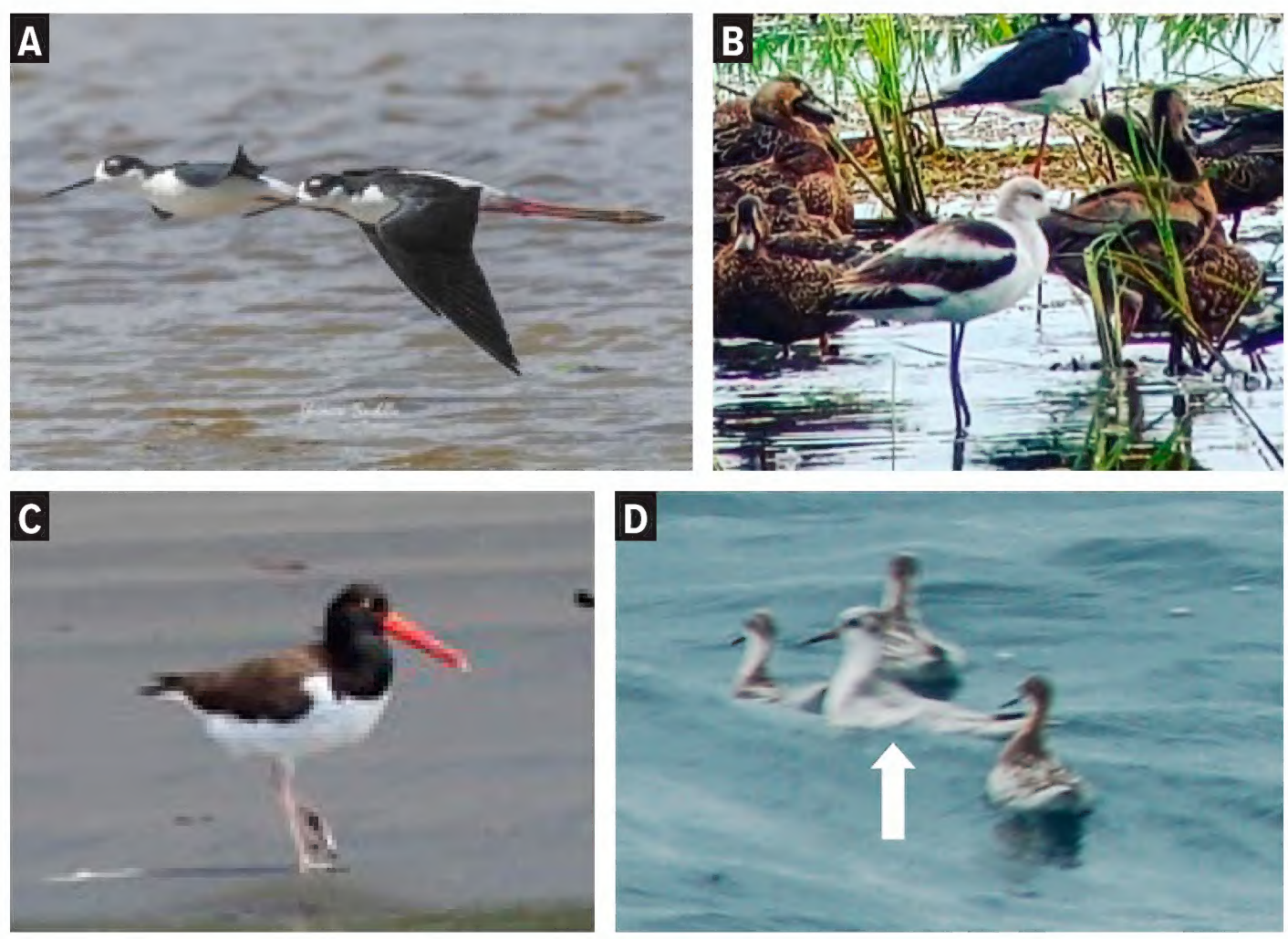

Figure 2. Some bird species recorded during incidental observations in Golfo Dulce: **A.** *Himantopus mexicanus* (credit: Yeimiri Badilla Agüero). **B.** *Recurvirostra americana* (credit: Julia Wurth). **C.** *Haematopus palliatus* (credit: Cristian Rodríguez Morales). **D.** *Phalaropus lobatus* and *Phalaropus fulicarius* (white arrow) (credit: Luis Sandoval).

Charadriidae

***Pluvialis dominica* Müller, 1766**
American Golden-Plover
Newly recorded from the area

Observations. COSTA RICA – Puntarenas • Golfo Dulce; between 08°34′22″N, 083°09′43″W; 13.VI.2014; A. Rojas-Barrantes obs.; seen solitary or in small groups in mangroves and sandy beaches. Recorded two times; first in Playa Azul (outer basin) and later in Esquinas river estuary (inner basin).

Identification. Set apart from the similar and very common *P. squatarola* by the lack of black axillar patch saw it at flight. Additionally, on nonbreeding plumage shows a clear whitish supercilium line.

***Charadrius vociferus* Linnaeus, 1758**
Killdeer
Newly recorded from the area

Observations. COSTA RICA – Puntarenas • Golfo Dulce; 08°38′32″N, 083°10′27″W; 02.IX.2014; A. Rojas-Barrantes obs.; first observed in Golfito Bay in an intertidal area, solitary. Also seen solitary or in small groups in river estuaries and grasslands along the rivers.

Identification. Two distinctive black bands on the chest set them apart from similar plovers.

Scolopacidae

***Limnodromus scolopaceus* Say, 1823**
Long-billed Dowitcher

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°34′22″N, 083°09′43″W ; 17.12.2022; A. Rojas-Barrantes obs.; outer basin, recorded one time. Foraging with other shorebirds in Playa Azul, by the estuary of Coto Colorado river.

Identification. Set apart by the barred patter in the tail, that is narrower than in very similar *L. griseus*.

***Calidris virgata* Gmelin, 1789**
Surfbird

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°43′20″N, 083°20′10″W ; 27.XI.2017; A. Rojas-Barrantes obs.; inner basin, recorded one time, solitary, by the estuary of Esquinas river.

Identification. Yellow legs and base of the bill set them apart from other similar plovers on breeding plumage.

***Calidris himantopus* Bonaparte, 1826**
Stilt Sandpiper

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°42′12″N, 083°19′57″W; 10.X.2016; A. Rojas-Barrantes obs.; inner basin, recorded one time, solitary, in a rocky shore by the estuary of Esquinas river.

***Tringa incana* Gmelin, 1789**
Wandering Tattler

Observations. COSTA RICA – Puntarenas • Golfo Dulce; 08°43′15″N, 083°20′04″W; 27.XI.2018; A. Rojas-Barrantes obs.; outer basin, recorded one time, solitary, in a rocky shore. Later, in January 2024, *T. incana* was observed again in Playa Pavones, outer basin, foraging in a rocky shore , reported on eBird database (https://ebird.org/checklist/S158391811) with photographic record.

***Phalaropus lobatus* Linnaeus, 1758**
Red-necked Phalarope
Figure 2D

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°21′07″N, 083°13′42″W ; 28.I.2017; L. Sandoval obs; outer basin. Recorded one time.

Identification. Set apart from similar *P. tricolor* by the white forehead in non-breeding plumage. Breeding individuals have a distinctive red coloration on the neck.

***Phalaropus fulicarius* Linnaeus, 1758**
Red Phalarope
Newly recorded from the area
Figure 2D

Observation. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°21′07″N, 083°13′42″W; 28.I.2017; L. Sandoval obs; outer basin. Recorded one time with *P. lobatus*.

Identification. Set apart from similar phalaropes by the distinctive red coloration in breeding plumage. Set apart from similar nonbreeding *P. lobatus* by the dark coloration on tail feathers and non-streaked back.

Stercorariidae

***Stercorarius pomarinus* Temminck, 1815**
Pomarine Jaeger
Figure 3A

Observation. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°21′07″N, 083°13′42″W; 28.I.2017; L. Sandoval obs; outer basin. Recorded one time.

Identification. Set apart from similar jaegers by the round shape of the extended tail feathers.

***Stercorarius parasiticus* Linnaeus, 1758**
Parasitic Jaeger
Newly recorded from the area
Figure 3B

Observation. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°21′07″N, 083°13′42″W; 28.I.2017; L. Sandoval obs; outer basin. Recorded one time.

Identification. Set apart from similar jaegers by a slender body shape, smaller head with thinner bill, and two pointed central tail feathers.

Laridae

***Leucophaeus pipixcan* Wagler, 1831**
Franklin's Gull

Observations. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°34′57″N, 083°09′55″W; 13.XII.2017; A. Rojas-Barrantes obs; outer basin, first observed foraging with terns in Playa Azul and later in Golfito Bay.

Identification. Set apart from similar gulls when showing black band on primaries when flying.

***Chroicocephalus philadelphia* Ord, 1815**
Bonaparte's Gull

Observation. COSTA RICA – PUNTARENAS • Golfo Dulce; between 08°27′N–08°45′N and 083°07′W–083°30′W; 05.1977; reported on literature by Garrigues and Dean (2014). No further information was provided.

Identification. The slender black bill is distinctive and set them apart from similar gulls. Also, small black patch behind the eyes can be used to recognize this species.

***Anous stolidus* Linnaeus, 1758**
Brown Noddy

Observation. COSTA RICA – PUNTARENAS • Golfo Dulce; between 08°27′N–08°45′N and 083°07′W–083°30′W; 03.2009; reported on literature by Young and Zook (2006), outer basin. No further information was provided.

Identification. A distinctive black bird with a white cap.

***Onychoprion anaethetus* Scopoli, 1786**
Bridled Tern
Newly recorded from the area
Figure 3C

Observation. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°21′07″N, 083°13′42″W; 28.I.2017; L. Sandoval obs.; outer basin, recorded one time, foraging with other gulls and terns.

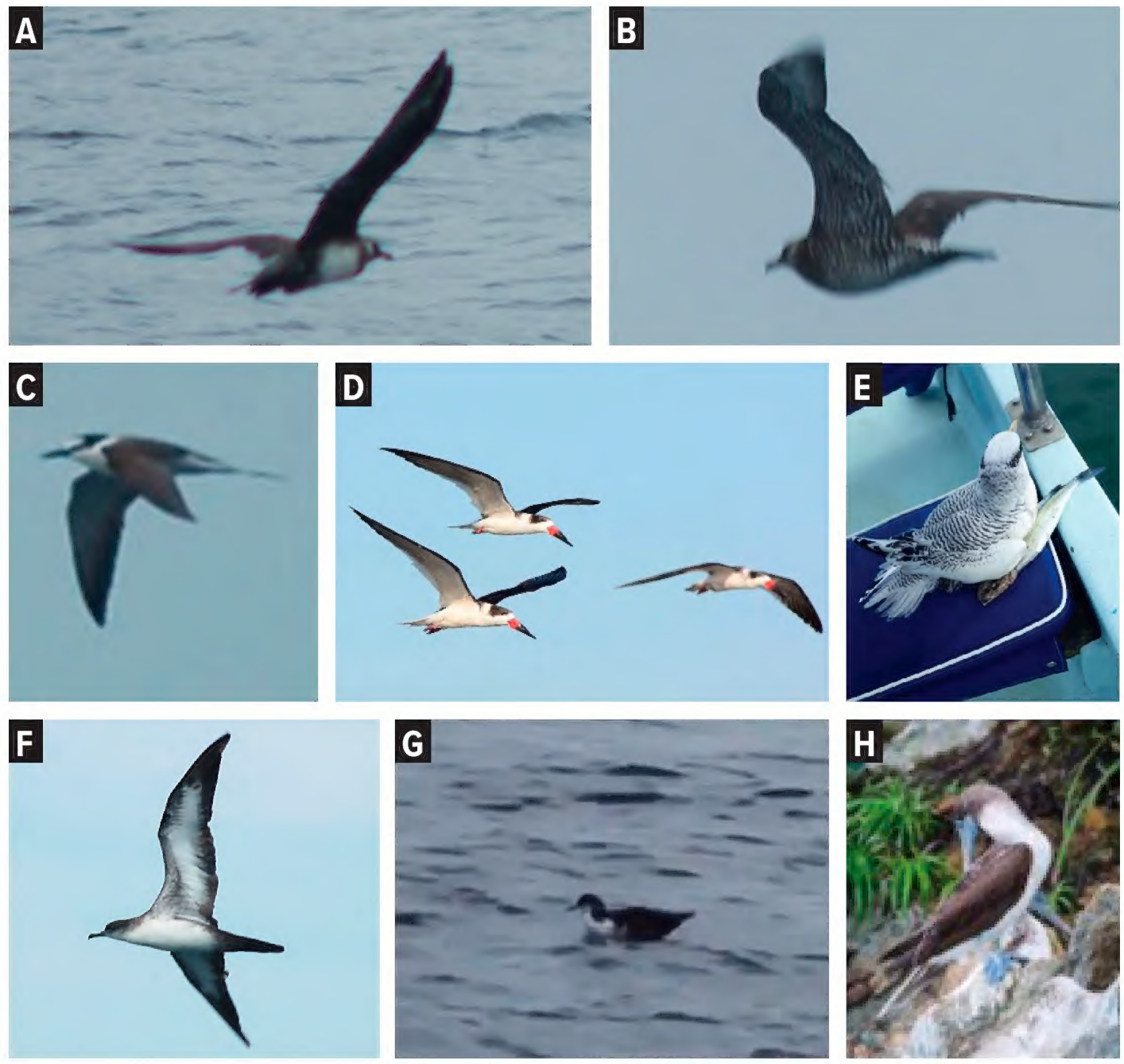

Figure 3. Some bird species recorded during incidental observations in Golfo Dulce: **A.** *Stercorarius pomarinus* (credit: Luis Sandoval). **B.** *Stercorarius parasiticus* (credit: Luis Sandoval). **C.** *Onychoprion anaethetus* (credit: Luis Sandoval). **D.** *Rynchops niger* (credit: Andrey Acosta Cabezas) **E.** *Phaethon aethereus* (credit: Yeiner Serracín). **F.** *Ardenna pacifica* (credit: Luis Sandoval) **G.** *Puffinus subalaris* (credit: Alejandra Rojas-Barrantes). **H.** *Sula nebouxii* (credit: Andrey Acosta Cabezas).

Identification. Set apart from the similar and very rare in the Pacific coast of Costa Rica *O. fuscatus* Linnaeus, 1766 by white forehead patch that reaches the area behind the eye, with a pale band or collar if present, on the neck. Additionally, this species has more extensive white underwings and tail edges.

***Sternula antillarum* Lesson, 1847**
Least Tern

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°32′32″N, 083°17′00″W; 29.XII.2017; A.Rojas-Barrantes obs.; outer basin recorded one time, seen resting in a mudbank with other gulls and terns..

Identification. The yellow bill and legs are distinctive.

***Gelochelidon nilotica* Gmelin, 1789**
Gull-billed Tern
Newly recorded from the area

Observations. COSTA RICA – Puntarenas • Golfo Dulce; 08°34′08″N, 083°19′01″W; 01.X.2019; A. Rojas-Barrantes obs; outer basin, first observed by the estuary of Tigre river. Later observed in Playa Azul. Seen in groups in river estuaries (intertidal mudflats) and sandbars. Usually foraging with other gulls and terns.

Identification. Set apart from other terns by the thick black bill, black cap on breeding individuals and black ear patch in nonbreeding individual.

***Rynchops niger* Linnaeus, 1758**
Black Skimmer
Figure 3D

Observations. COSTA RICA – Puntarenas • Golfo Dulce; 08°34′5″N, 083°09′55″W; 15.XII.2015; A. Rojas-Barrantes obs.;outer basin, first observed by the estuary of Coto Colorado river. Seen in river estuaries (intertidal mudflats) and sandy areas. Solitary or in small groups.
Newly recorded from the area

Identification. Set apart from other terns and gulls based in the red and black bill with elongated mandible.

Phaethontidae

***Phaethon aethereus* Linnaeus, 1758**
Red-billed Tropicbird
Figure 3E

Observations. COSTA RICA – Puntarenas • Golfo Dulce; 08°39′17″N, 083°18′20″W ; 20.IX.2018; A. Rojas-Barrantes obs.; inner basin, recorded one time. Observed individual landed on a boat, holding a prey (medium size fish). Bird seemed either exhausted or sick, as it did not show signs of distress or attempted to fly away when approached by humans. Later, on December 2023 *P. aethereus* was observed in flight, reported on eBird database https://ebird.org/checklist/S156151255

Identification. Body with white feathers with black-barred back and base of upper wing. Black eye stripe and yellowish bill.

Procellariidae

***Ardenna pacifica* Gmelin, 1789**
Wedge-tailed Shearwater
Figure 3F

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°21′07″N, 083°13′42″W; 04.IV.2007; L. Sandoval obs.; outer basin. Recorded one time.
Newly recorded from the area

Identification. Differs from *Puffinus subalaris* in size (larger) and shape of the tail (more pointed, wedge-like). The underparts are less defined than *P. subalaris*. Dark grey bill with black tip. Pelagic.

***Puffinus subalaris* Ridgway, 1897**
Galapagos Shearwater
Figure 3G

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°32′58″N, 083°18′26″W; 19.II.2019; A. Rojas-Barrantes obs.; outer basin, recorded one time during the dry season, surface seizing (a feeding method) in the water, solitary.
Newly recorded from the area

Identification. Set apart from similar shearwaters by its darker upperparts and pale down parts. Pelagic.

***Puffinus lherminieri* Lesson, 1839**
Audubon's Shearwater

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°21′07″N, 083°13′42″W; 04.IV.2007; L. Sandoval obs.; outer basin. Recorded one time.
Newly recorded from the area

Identification. Set apart from similar shearwaters by its darker upperparts and pale down parts. Pelagic.

Ciconiidae

***Mycteria americana* Linnaeus, 1758**
Wood Stork

Observations. COSTA RICA – Puntarenas • Golfo Dulce; 08°43′20″N, 083°20′10″W; 4.III.2018; A. Rojas-Barrantes obs.; inner basin, first observation was in the estuary of Esquinas river; three individuals foraging in mudflats.. Also seen in the estuary of Coto Colorado river.

Identification. Big size and lightly curved bill are distinctive. Only bird with these characteristics in the study area. It might be confused with *Jabiru mycteria* Lichtenstein, 1819 however, there is no geographic overlap.

Sulidae

***Sula dactylatra* Lesson, 1831**
Masked Booby

Observation. COSTA RICA – Puntarenas • Golfo Dulce; 08°23′37″N, 083°10′41″W; 30.IV.2017; A. Rojas-Barrantes obs.; outer basin, recorded one time, solitary, on a rocky area.

Identification. Differs from other boobies by the dark color of the feet and color of the bill (yellow). Head is complete white in adults.

***Sula nebouxii* Milne-Edwards, 1882**
Blue-footed Booby
Figure 3H

Observations. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°37′37″N, 083°14′13″W; 20.VI.2017; A. Rojas-Barrantes obs.; outer basin, first observed in a particular congregation during the rainy season, in a rocky shore (Punta Gallardo). Later in June 2023, a small group was observed in the same location. Common in exposed rocks and rocky shores. Solitary or in groups.

Identification. Differs from other boobies by their blue legs.

***Sula sula* Linnaeus, 1766**
Red-footed Booby

Observation. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°20′45″N, 083°07′35″W; 07.I.2014; A. Rojas-Barrantes obs.; outer basin. Recorded one time. Solitary, on a rocky area.
Newly recorded from the area

Identification. Differs from other boobies by their red legs.

***Sula variegata* Tschudi, 1843**
Peruvian Booby

Observation. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°22′55″N, 083°17′29″W; 25.V.2023; eBird report; outer basin, on a rocky area. Reported on eBird database (https://ebird.org/species/perboo1/CR List S142689331). No further information provided.

Newly recorded from the area

Identification. Differs from other boobies by the combination of white head and grey legs and bill.

Anhingidae

***Anhinga anhinga* Linnaeus, 1766**
Anhinga

Observations. COSTA RICA – PUNTARENAS/GOLFITO • Golfo Dulce; 08°37′43″N, 083°09′33″W; 02.IX.2014; A. Rojas-Barrantes obs.; first observed in Golfito Bay, commonly seen solitary or in small groups in shallow water near the shore and river estuaries.
Newly recorded from the area

Identification. The shape of the needle-like bill is distinctive. Show sexual dimorphism, where females are different than males in having a brownish upper part of the body.

Phalacrocoracidae

***Nannopterum brasilianus* Gmelin, 1789**
Neotropical Cormorant

Observations. COSTA RICA – PUNTARENAS • Golfo Dulce; 08°38′12″N, 083°10′38″W 15.XII.2015; A. Rojas-Barrantes. obs.; first observed in Golfito Bay, near Playa Cacao. Commonly seen solitary or foraging with other birds near the shore and river estuaries.
Newly recorded from the area

Identification. The shape of the bill is distinctive. Juveniles are pale.

***Agamia agami* Reichenbarch, 1853**
Agami heron

Observations. COSTA RICA – PUNTARENAS • Golfo Dulce; between 08°27′N–08°45′N and 083°07′W–083°30′W; 2014; reported on literature by Garrigues and Dean (2014), solitary, seen near streams and swamps in the coast.

Identification. The long bill is distinctive. Dark colors can set them apart from similar herons like *T. mexicanum.*

DISCUSSION

The 1998 UBI list includes 58 bird species in 11 families. From this list, we could not confirm five species by either our own observations or from historical records, the literature, or citizen-science platforms; these five species are: *Ixobrychus exilis* Gmelin, 1789 , *Calidris alpina*,Linnaeus, 1758, *Calidris canutus*,Linnaeus, 1758 *Calidris melanotos* Vieillot, 1819, and *Tigrisoma lineatum* Boddaert, 1783. We suggest that the record of *T. lineatum*, a species which does not occur on the Pacific slope, may be a misidentification of *T. fasciatum*, which is rare and a recent colonizer of the interior area of the Osa Peninsula (Garrigues and Dean 2014), or perhaps of the more common *T. mexicanum*.

Two species in the UBI list, *Agamia agami* and *Chroicocephalus philadelphia* were not confirmed by our observations, but there are literature records. Garrigues and Dean (2014) mentioned both species as rare in the Golfo Dulce coastal area, and eBird has recent observations in nearby area La Gamba for *A. agami*. For *C. philadelphia*, Garrigues and Dean (2014) mentioned May 1979 as the observation date. At the time of publication of Garrigues and Dean's (2014) field guide, the last observation of *C. philadelphia* was in January 2013 in Playa Potrero, Guanacaste, northern Pacific of Costa Rica, and is described as a casual winter visitor. The most recent observation of *C. philadelphia* in Costa Rica reported on eBird (eBird list S99276953) was in Tamarindo, Guanacaste in 2019.

The family with the most species observed was Scolopacidae (shorebirds). This is expected due to the suitability of coastal habitats as a feeding ground in Golfo Dulce. Shorebirds congregated in mangrove ecosystems at river estuaries, with higher congregations at the mouths of the Esquinas, Coto Colorado, and Tigre rivers, and at Playa Azul, a long sandy beach near Golfito Bay (Figure 1). Four Near Threatened species, *Egretta rufescens, Thalasseus elegans*, *Calidris pusilla*, and *Charadrius nivosus*, were all observed using these congregation sites. The ability of a site to support large numbers of shorebirds is largely determined by the extent of intertidal sand and mudflats and by the density, availability, and seasonal predictability of their invertebrate prey; sites with greater densities of invertebrates typically support higher shorebird densities (Galbraith et al. 2002).

Golfo Dulce shows a relatively healthy environment (Morales-Ramírez 2011), and it does not show high rates of pollution from pesticides or hydrocarbons (Acuña-González et al. 2004; Sponberg 2004; Sponberg et al. 2011). Nonetheless, as suggested by Morales-Ramírez (2011), efforts to restore Golfito Bay are needed. We note the importance of addressing the effects of coastal developments for tourism without sustainable planning, especially in Golfito Bay, where development has impacted bird habitats, such as mangroves. According to Román and Angulo (2013), tourism and fishing are the activities that most directly impact marine-coastal resources in the region; however, there are no historical records to show how these activities have affected marine avian diversity in Golfo Dulce.

The conservation of marine birds have received little attention in Costa Rica (Barrantes and Chaves-Campos 2009). Pollution from pesticides, sewage, and solid waste, as well as habitat destruction, are threats to marine avifauna in Costa Rica. With the increase in recent pollution events from hydrocarbon (from fishing vessels) and small-scale palm-oil spills (from tankers for oil exportation) in Golfito Bay (pers. obs.), coupled with the inadequate management of solid waste, we recommend the frequent monitoring of this type of sea pollution be undertaken. Inadequate environmental guidelines in the port for the palm oil and fishery industries could be responsible for increased threats to marine birds in Golfo Dulce from these activities.

Climate change is a major threat to marine avifauna in Golfo Dulce due to rising sea levels, warming and acidification of water, and more frequent extreme weather events. Projections have inferred that PBNP is highly vulnerable to future climate change, with outcomes that include changes in temperature and precipitation, ocean swells, the frequency of extreme climatic events, and the El Niño Southern Oscillation (BIOMARCC-SINAC-GIZ 2013).

Sea warming will impact the abundance and quality of the prey for waterbirds and change the biota of the intertidal habitats in which these birds forage, with changes expected to local and even national patterns of bird distributions (Kendall et al. 2004). The rise in the sea level may change the complexity of the coastline, thereby fragmenting habitats, and the reduction in foraging area may be a major contributor to the decline of shorebird populations (Convertino et al. 2012). As mentioned earlier, most species in this study are shorebirds. A rising sea level would make intertidal areas to fully subtidal and result in reduced foraging habitats for shorebirds (Galbraith et al. 2002), and such a change would be greatest where the intertidal zone is not able to shift inland either by topography or by seawalls (Galbraith et al. 2002). Such a situation may occur in the northwestern Golfo Dulce, where forests act as a topographic wall. Because of the minor anthropogenic development in this area of the gulf, the coastal wetland habitats are especially important as feeding grounds for Nearctic migratory species.

Given that much of the data of interest for this study comes from observations made in the Esquinas river, we emphasize the need to strengthen the research and monitoring program of the corresponding conservation area for PBNP (Osa Conservation Area). This river and its estuary, which serve as the natural limit of the protected area, consists of flood-prone areas vulnerable to climate change scenarios, and is also being affected by anthropogenic impacts such as the use of illegal fishing arts and water pollution by pesticides from upstream agricultural plots (SINAC 2015). At the same time, improving the control and

protection program in Esquinas river and its habitats would contribute to the conservation of the ecological integrity of the important feeding grounds for marine birds.

Long-term monitoring, such as annual bird counts and counts in selected plots, is a fundamental tool in understanding how ecosystems change over time. Therefore, obtaining ecological data is critical to understanding the resilience, stability, and changes in an ecosystem (Chiappa-Carrara et al. 2017). This highlights the relevance of projects such as the Golfito Bird Counts, from which most of the data for this study was obtained. The Golfito Bird Count, a citizen science approach, is an annual monitoring project, supported by the community participation. It allows obtaining information of interest for monitoring environmental changes in the marine-coastal ecosystems of Golfito, and analyzing the long-term population dynamics of birds at a local level. This project also promotes that scientific knowledge must be accessible and beneficial for the community.

As citizen-science projects are rapidly increasing in aims of achieving the 2030 Agenda for Sustainable Development Goals (de Sherbinin et al. 2021), it is imperative that citizen science follows standards and is curated by experts so that the data obtained are reliable over time. According to Si and Ding (2011), Sullivan et al. (2014) and Randler (2021) one example of successful citizen science project is applied in ornithology, and one of the earliest to do it, because birdwatchers spend a large amount of time collecting data. Basic and low-involvement projects like Christmas Bird Counts that can be based on a single time point in data collection, can conveniently contribute to the generation of knowledge, while social dimensions are also addressed (Randler 2021).

As suggested by Sullivan et al. (2014), citizen science is better accomplished by expanding the range of activities beyond data collection, including community engagement, data curation, data synthesis and analysis, pattern visualization, and delivery of results to a broad community of possible stakeholders. In this context, the Golfito Bird Counts, followed a well-established methodology and sampling protocol. At the same time, it has expanded its scope of action, reaching a community commitment and democratization of science that ensures the continuity of this joint effort.

It is remarkable the modern use of global citizen science platforms like eBird. The eBird project is generating biodiversity data which are increasing for different uses (Sullivan et al. 2014), in our case, it allowed us not only to confirm records, but to grow the regional data input, which can be harnessed for monitoring the distribution of resident and migratory birds for future research in the area.

We recommend continuing the Golfito Bird Counts through the involvement of citizens and with strategic alliances, including Piedras Blancas National Park. Moreover, specific marine monitoring would be particularly beneficial to study seasonality and relative abundance of bird species over time.

ACKNOWLEDGEMENTS

We acknowledge the sponsors of the Golfito Bird Counts, especially Victor Rojas from Arquissur, Lorena and Ana María Barrantes, Playa Cativo Lodge (Mark Betts), and Cielo Lodge (Keith and Nicole Goldstein). We extend our gratitude to Catalina Torres and Allen Mairena. We thank the Cámara de Turismo del Golfo Dulce and the Sistema Nacional de Áreas de Conservación (Piedras Blancas National Park and Golfito National Wildlife Refuge). Special thanks to the citizens who have been part of this data collection: naturalist guides, volunteers, park rangers, and boat captains, whose knowledge about Golfo Dulce birds' hotspots has been invaluable. Thanks also extended to Mary Ann Good for language review and suggestions to the manuscript, and to anonymous reviewers and subject editor. ARB dedicates this paper to the memory of Virginia Lobo y García Menocal (Beba). LS thanks Vicerrectoría de Investigación for the support under the project number C2706.

ADDITIONAL INFORMATION

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

Funding

This study received no specific funding.

Author contributions

Conceptualization: ARB. Data curation: ARB, LS. Formal analysis: ARB, LS. Methodology: ARB, LS. Supervision: LS. Visualization: ARB, LS. Writing – original draft: ARB. Writing – review and editing: ARB, LS.

Author ORCID iDs

Alejandra Rojas-Barrantes https://orcid.org/0009-0007-3293-4499

Luis Sandoval https://orcid.org/0000-0002-0793-6747

Data availability

All data that support the findings of this study are available in the main text.

REFERENCES

Acuña-González J, Vargas-Zamora JA, Gómez-Ramírez E, García-Céspedes J (2004) Hidrocarburos de petróleo, disueltos y dispersos, en cuatro ambientes costeros de Costa Rica. Revista de Biología Tropical 52 (2): 43–50.

Allen PH (1956) The rainforests of Golfo Dulce. Stanford Univ. Press, Stanford, CA, USA, 365 pp.

American Birding Association (2022) http://www.aba.org USA. Accesed on: 2022-02-10

Araya Ajoy YM (2005) Efecto del ciclo de marea en la composición de aves en la zona intermareal del manglar Llano Bonito. Universidad de Costa Rica, curso Biología de Campo, Golfito, Costa Rica, 3–8.

Barrantes G, Chaves-Campos J (2009) Birds in coastal and marine environments. In: Wehrtmann IS, Cortés J (Eds.) Marine biodiversity of Costa Rica, Central America. Springer, Dordrecht, the Netherlands, 469–478. https://doi/org/10.1007/978-1-4020-8278-8_44

Bessesen BL (2015) Occurrence and distribution patterns of several marine vertebrates in Golfo Dulce, Costa Rica. Revista de Biología Tropical 63 (1): 261–272. https://doi.org/10.15517/rbt.v63i1.23106

BIOMARCC-SINAC-GIZ (Biodiversidad marino-costera de Costa Rica-Sistema Nacional de Áreas de Conservación-Deutsche Gessellschaft für Internationale Zusammenarbeit) (2013) Análisis de la vulnerabilidad de las zonas oceánicas y marino costeras de Costa Rica frente al cambio climático. San José, Costa Rica, 103 pp.

Bussing W, López MI (1996) Fishes collected during the RV *Victor Hensen* Costa Rica Expedition (1993/1994). Revista de Biología Tropical 44 (3): 183–186.

Chesser RT, Billerman SM, Burns KJ, Cicero C, Dunn JL, Hernández-Baños BE, Kratter AW, Lovette IJ, Mason NA, Rasmussen PC, Remsen JV, Stotz DF, Winker K (2023) Sixty-fourth supplement to the American Ornithological Society's Checklist of North American Birds. Ornithology 140 (3): ukad023. https://doi.org/10.1093/ornithology/ukad023

Chiappa-Carrara X, Enriquez C, Mariño-Tapia I, Badillo M, Gallardo A, Yañez-Arenas C (2017) Monitoreo ambiental de largo Plazo, herramienta para evaluar la resiliencia de sistemas costeros In: Garza-Pérez JR, Ize-Lema I (Eds.) Caracterización multidisciplinaria de la zona costera de Sisal, Yucatán: hacia una gestión integral y fortalecimiento de la resiliencia. -Laboratorio Nacional de Resiliencia Costera, Sisal,Yucatán, Mexico, 90 –101.

Convertino M, Bockelie A, Kiker GA, Muñoz-Carpena R, Linkov I (2012) Shorebird patches as fingerprints of fractal coastline fluctuations due to climate change. Ecological Processes 1 (1): 9. https://doi.org/10.1186/2192-1709-1-9

Cortés J (1990) The coral reefs of Golfo Dulce, Costa Rica: distribution and community structure. Atoll Research Bulletin 344: 1–37.

Cortés J (1992) Los arrecifes coralinos del Golfo Dulce, Costa Rica: aspectos ecológicos. Revista de Biología Tropical 40: 19–26.

Droege S, Cyr A, Larivée J (1998) Checklists: an under-used tool for the inventory and monitoring of plants and animals. Conservation Biology 12 (5): 1134–1138. https://doi.org/10.1046/j.1523-1739.1998.96402.x

Fritz S, See L, Carlson T, Mordechai H, Oliver J, Fraisl D, Mondardini R, Brocklehurst M, Shanley L, Schade S, When U, Abrate T, Anstee J, Arnold S, Billot M, Campbell J, Esprey J, Gold M, Hager G, He S (2019) Citizen science and the United Nations sustainable development goals. Nature Sustainability 2: 922–930. https://doi.org/10.1038/s41893-019-0390-3

Galbraith H, Jones R, Park R, Clough J, Herrod-Julius S, Harrington B, Page G (2002) Global climate change and sea level rise: potential losses of intertidal habitat for shorebirds. Waterbirds 25 (2): 173–183. https://doi.org/10.1675/1524-4695

Garrigues R, Dean R (2014) The birds of Costa Rica. Second edition. Zona Tropical, Cornell University Press, Ithaca, USA, 425 pp.

Guzmán-Mora AG, Molina-Ureña H (2008) The artisanal finfish fishery in the Golfo Dulce, Costa Rica. In: Proceedings of the 60th Gulf and Caribbean Fisheries Institute. Punta Cana, Dominican Republic, 138–142.

Hebbeln D, Beese D, Cortés J (1996) Morphology and sediment structures in Golfo Dulce, Costa Rica. Revista de Biología Tropical 44 (3): 1–10.

IUCN (International Union for Conservation of Nature) (2023) The IUCN Red List of Threatened Species. Version 2023-1. https://www.iucnredlist.org/en Accesed on: 2023-06-04.

Kendall MA, Burrows MT, Southward AJ, Hawkins SJ (2004) Predicting the effects of marine climate change on the invertebrate prey of the birds of rocky shores. Ibis 146: 40–47. https://doi.org/10.1111/j.1474-919X.2004.00326.x

Knauss JA (1978) Introduction to physical oceanography. Prentice-Hall, New York, USA, 338 pp.

Morales-Ramírez Á (2011) La diversidad marina del Golfo Dulce, Pacífico sur de Costa Rica: amenazas de conservación. Biocenosis 24: 1–2.

National Audubon Society (2022) https://www.audubon.org/conservation/join-christmas-bird-count USA Accesed on: 2022-02-10

Palacios-Martínez GE (2015) Shallow reef fishes around "La Viuda" rocky islet, Golfo Dulce, Costa Rica. Revista de Biología Tropical 63: 329–338.

Quesada-Alpízar MJ, Cortés J, Alvarado J, Fonseca A (2006). Características hidrográficas y biológicas de la zona marino-costera del Área de Conservación Osa. Serie Técnica: Apoyando los esfuerzos en el manejo y protección de la biodiversidad tropical. The Nature Conservancy, San José, Costa Rica, 80 pp.

Rajpar MN, Ozdemir I, Zakaria M, Sheryar S, Rab A (2018) Seabirds as bioindicators of marine ecosystems. In: Mikkola H (Ed.) Seabirds. IntechOpen, London, UK, 47–65.

Ralph CJ (1981) Terminology used in estimating numbers of birds: estimating numbers of terrestrial birds. Studies in Avian Biology 6: 577–578.

Ralph CJ, Geupel GR, Pyle P, Martin TE, DeSante DF (1993) Handbook of field methods for monitoring landbirds. USDA Forest Service, Pacific Southwest Research Station, Albany, CA, USA, 141 pp.

Randler C (2022) Motivations and specialization of birders are differently related to engagement in citizen science projects of different complexity. Behavioral Sciences 12 (10): 395. https://doi.org/10.3390/bs12100395

Richards FA, Anderson JJ, Cline JD (1971) Chemical and physical observations in Golfo Dulce, an anoxic basin on the Pacific coast of Costa Rica. Limnology and Oceanography 16: 43–50. https://doi.org/10.4319/lo.1971.16.1.0043

Román M, Angulo J (2013) Panorama socioeconómico de los cantones de Osa y Golfito: tendencias y desafíos para el desarrollo sostenible. INOGO, Stanford Woods Institute for the Environment, San José, Costa Rica, 74 pp.

Samper-Villarreal J, Silva-Benavides AM (2015) Complejidad estructural de los manglares de Playa Blanca, Escondido y Rincón de Osa, Golfo Dulce, Costa Rica. Revista de Biología Tropical 63: 199–208.

Samper-Villarreal J, van Tussenbroek BI, Cortés J (2018) Seagrasses of Costa Rica: from the mighty Caribbean to the dynamic meadows of the eastern tropical Pacific. Revista de Biología Tropical 66 (1): 53–65.

Sandoval L, Sánchez C (2020). Lista de aves de Costa Rica. Vigésima novena actualización. Unión de Ornitólogos de Costa Rica, San José, Costa Rica, 40 pp.

Schreiber EA, Burger J (2001) Biology of marine birds. CRC Press, Boca Raton, FL, USA, 665 pp.

de Sherbinin A, Bowser A, Chuang T R, Cooper C, Danielsen F, Edmunds R, Elias P,Faustman E,Hultquist C, Mondardini R,Popescu I, Shonowo A, Sivakumar K (2021) The critical importance of citizen science data. Frontiers in Climate 3 (20): 650760. https://doi.org/10.3389/fclim.2021.650760

Si X, Ding P (2011) History, status of monitoring land birds in Europe and America and countermeasures of China. Biodiversity Science 19 (3): 303.

SINAC (Sistema Nacional de Áreas de Conservación) (2015) Diagnóstico del área silvestre protegida: Parque Nacional Piedras Blancas, Área de Conservación Osa, Región Brunca. San José, Costa Rica, 126 pp.

Spongberg AL (2004) PCB contamination in marine sediments from Golfo Dulce, Pacific coast of Costa Rica. Revista de Biología Tropical 52: 23–32.

Spongberg AL, Witter JD, Acuña J, Vargas J, Murillo M, Umaña G, Perez G (2011) Reconnaissance of selected PPCP compounds in Costa Rican surface waters. Water Research 45 (20): 6709–6717. https://doi.org/10.1016/j.watres.2011.10.004

Stiles FG, Skutch AF (1989) A guide to the birds of Costa Rica. Editorial INBio, Heredia, Costa Rica, 700 pp.

Sullivan BL, Aycrigg JL, Barry JH, Bonney RE, Bruns N, Cooper CB, Kelling S (2014) The eBird enterprise: an integrated approach to development and application of citizen science. Biological Conservation 169: 31–40. https://doi.org/10.1016/j.biocon.2013.11.003

Universidad de Costa Rica (2023) Sistema de Bibliotecas, Documentación e Información de la Universidad de Costa Rica. San José, Costa Rica. https://sibdi.ucr.ac.cr/. Accessed on: 2023-03-05.

Universidad Estatal a Distancia (2023) Repositorio Institucional de la Universidad Estatal a Distancia. San José, Costa Rica. https://repositorio.uned.ac.cr/. Accessed: 2023-03-05.

Universidad Nacional (2023) Repositorio de la Universidad Nacional. Heredia, Costa Rica. https://repositorio.una.ac.cr/. Accessed on: 2023-03-05.

Weissenhofer A, Huber W, Koukal T, Immitzer M, Shembera, E, Sontag S, Zamora N, Weber A (2008) Ecosystem diversity in the Piedras Blancas National Park and adjacent areas (Costa Rica). OÖ Landesmuseen, Freidstat, Austria, 34 pp.

Wolff M, Hartmann HJ, Koch V (1996) A pilot trophic model for Golfo Dulce, a fjord-like tropical embayment, Costa Rica. Revista de Biología Tropical 44 (3): 215–231.

Young BE, Zook JR (2016) Observation frequency and seasonality of marine birds off the Pacific coast of Costa Rica. Revista de Biología Tropical 64: 235–248. https://doi.org/10.15517/rbt.v64i1.23453